Appendix F – Environmental Impacts of Flooding

1. Floodplain Development. West Virginia is blessed with a diverse terrain of high mountains, rolling uplands, wide plateaus, and deep river valleys. This rich topographic diversity has resulted in a linear system of floodplains across the State. West Virginia has approximately 31,000 miles of rivers and streams in 32 major river watersheds. These watersheds are shown in Map F-1 below. The State's waterways are bordered by thousands of acres of floodplains: all subject to flooding.

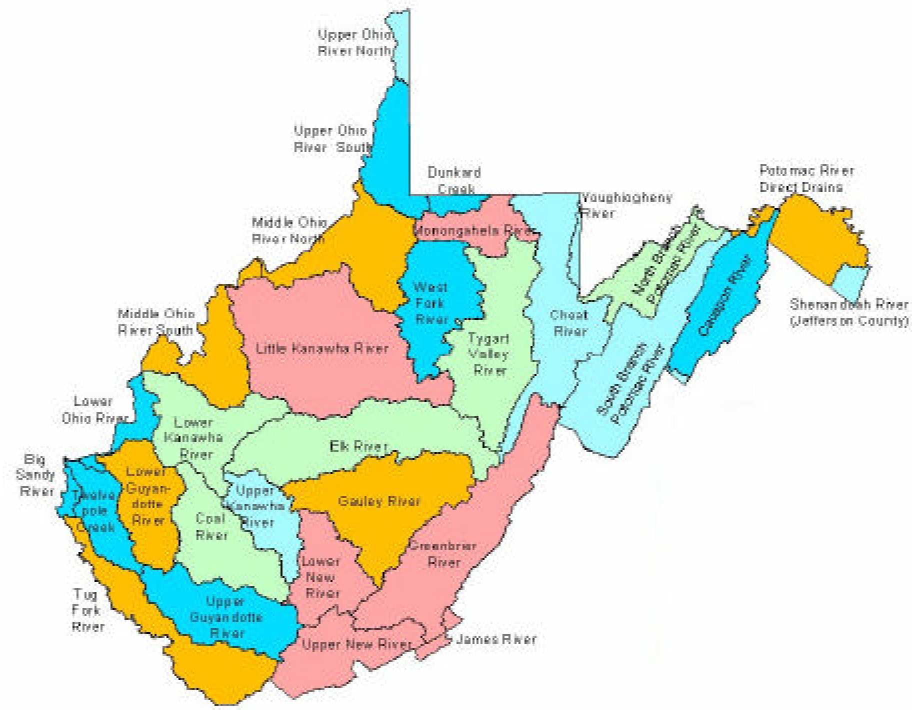

Figure F-1. Major Watersheds in West Virginia

Over thousands of years a combination of tectonic mountain building, gravity, and precipitation have created our current landscape by rivers down-cutting into plateaus, streams meandering back and forth across the land, eroding mountainsides and stream banks, and depositing sediment. Riverine floodplains in West Virginia are one part of our natural landscape created by these natural forces. Floodplains are the corridors of land along a river that are occasionally inundated by water that overflows the river channel. Their ability to temporarily store excess runoff is a significant attribute of floodplains. The ever-changing floodplain is delineated and sculpted by a combination of climatic rainfall patterns, runoff from surrounding land, the underlying geological strata, and resulting soil associations.

Given their constant evolution through hydraulic processes, floodplains are as much a part of the waterway as the stream channel itself. The absence of overflows across the floodplain in any given year is balanced by the thousands of high-water events that created and nourished the same floodplain during the past thousands of years. The presence or absence of certain flora and fauna in the floodplain testify to the natural forces present in this corridor. The floodplain has been referred to by some as the "Kingdom of the River" and any intruders are subject to the river's recurring wrath.

The State's floodplains are an incubator and home to a wide variety of flora and fauna. Figure F- 2 shows the floodplain corridor separating the stream from cultivated fields. The diversity and total natural production of these floodplain ecosystems may be beyond our capacity for measurement. A mixture of bottomland hardwoods, riverine wetlands, riparian ecosystems, and open fields, floodplains produce a diverse pattern of vegetation. In addition to the natural productive capacity of the State's floodplains, they serve as sponges, both attenuating the severity of high flows and transferring and filtering surface water into the groundwater table.

Figure F-2. Riparian corridor within cultivated fields

2. Floodway Development. Within the floodplain is a narrower corridor consisting of the river channel and its immediate edges. This area, defined by regulatory agencies as the "floodway" is shown in Figure F-3 below. While not always naturally identifiable, the floodway zone is delineated by computer models combining stream and floodplain cross-sections and estimated (or known) water volumes.

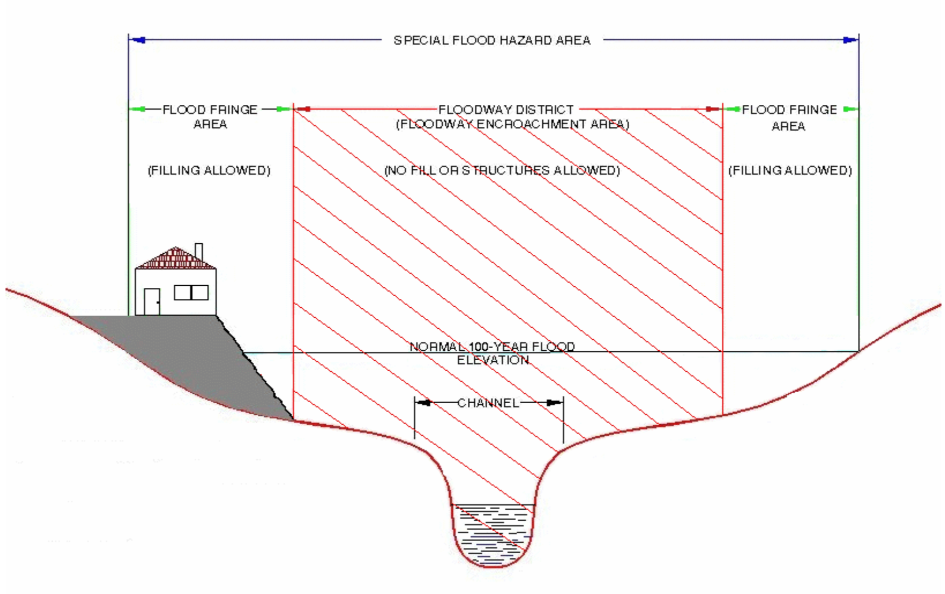

Figure F-3. Schematic showing the relationship of the floodway to the stream channel and the flood fringe area.

The floodway zone carries the greatest volume of floodwaters, is characterized by the highest velocity flows, and transports the greatest amount of sediment and debris. For this reason, during high flows, the floodway zone is the area where most destruction and flood damage occurs. The majority of water-borne sediments are deposited in the flood fringe area where floodwater velocities are reduced. Due to the volume of water that passes through the floodway zone, any constriction of this zone (through placement of structures or fill) can significantly affect both the elevation of the flow and the patterns of material deposition and scour. The floodway zone has been recognized by Federal and State legislation and agencies as a highly dangerous location for development. In areas of the State where stream gradients are steep, floodway zones can be extremely destructive to all forms of development.

In an effort to curb development within the State's floodways, the Task Force recommends that the Governor issue an executive order declaring the State's floodways to be off- limits to development unless floodplain managers receive site-specific documentation from a WV registered professional engineer, or a Federal or State agency which proves that the proposed floodway development: (1) does not result in an increase in the water surface elevation of the 100-year flood event, (2) has been designed and will be constructed to a standard that will withstand the water depths and velocities associated with the floodway location, and (3) if a Federally subsidized or constructed facility, has been evaluated according to Federal Executive Order 11988. This requirement is in accordance with current floodplain management ordinances.

3. Protection of Floodplains. West Virginia's floodplains vary in width from very narrow along upland streams to very broad along the major rivers such as the Ohio, the Kanawha or the Potomac. As indicated above, the width of the floodplain is determined by the size of the watershed above it, the erosion characteristics of the soils and underlying rock, and the stream pattern.

Mankind’s intrusion into an undisturbed watershed and its floodplain causes numerous environmental problems. Streams assume a certain channel size and shape to accommodate the runoff associated with the size of the watershed and the type of land cover present. Although the capacity of the channel is occasionally exceeded by extreme rainfall events, most storms are accommodated without significant impacts or changes to the stream channel size, shape or ecology. Forested watersheds that have been spared devastation by fire and have maintained an intact humus layer absorb enormous amounts of rainfall (as high as 70 to 90 percent). This rate of absorption results in relatively small amounts of runoff and extended times of concentration Converting forests to other land uses increases stormwater runoff and stream sedimentation and decreases time of concentration. Figure F-4 is an example of one type of land use conversion that increases both runoff and sedimentation.

Figure F-4. Land Use conversion generating runoff and sedimentation

Any significant reduction in the forest cover, for whatever purpose or type of development, reduces the capacity of the vegetation and soil to attenuate stormwater runoff volumes and slow concentration times (the time water rests on the surface where it can soak into the ground). In regions of steep terrain, runoff concentration times are already short adding to the impacts of land disturbance. Since converting forestland to other uses usually includes constructing roads, consolidating soil materials, and creationg impervious surfaces, both runoff and sedimentation are increased beyond what simple vegetation loss would produce. Roads, unless properly designed and constructed to reduce runoff and sedimentation, act as direct conduits of stormwater runoff and sedimentation to the streams. Figure F-5 shows a steep access road that will serve as a runoff conduit during rainfall events. Roads of this sort are frequently found at mine sites, timber operations, and during construction of subdivisions and commercial facilities.

Figure F-5. Steep access road in timber removal area

Erosion of access roads dramatically increases the sediment deposition in nearby streams. Impervious surfaces and compacted soils (which essentially mimic impervious surfaces) convey nearly 100 percent of rainfall as stormwater runoff. Rapidly conveying increasing amounts of runoff into otherwise stable stream channels results in unstable stream channel geometry and damaged aquatic ecosystems. Erosion and sedimentation further modifies the stream channel and impacts the aquatic community. Repeated bank-full flows scour the bottom and sides of the channel. Figure F-6 shows bank erosion associated with high flows.

Figure F-6. Bank erosion caused by high flows

Greater flow volumes can accommodate a greater sediment load, and therefore the stream cuts into the banks and streambed to obtain the optimum load. Eventually, when the stream velocity slows, the newly acquired sediment load is deposited within the channel or on the adjacent floodplains.

In addition, construction within the floodplain often occurs without consideration for the floodplain's functions as a part of the river channel. The floodplain is a normally inactive portion of the river channel that can accommodate larger flows. It is like building one's home on the known pathway of previous landslides, lava flows, or avalanches—eventually the result is catastrophic.

These unwise intrusions lead to repetitive losses of life and property.
In addition to the basic risks associated with just living and working in the floodplain, we've exacerbated the flooding problems by filling in the floodways to the detriment of all surrounding development. We also cross the stream channel wherever and however it is most convenient without much consideration for the stream channel. While not obvious in this photograph, Figure F-7 shows an inadequately designed and constructed stream crossing. Stream-channel constrictions by structures, fill materials, bridge piers, bridge beams, culverts, and low-water bridges all contribute to flooding.

Figure F-7. Inadequately designed/ constructed stream crossing

Adding to the fact that development in the floodway and floodplain restricts flows during flood events, runoff from floodplain development is channeled directly into the stream, further increasing stormwater runoff in the watershed and increasing the potential for flash floods. In many cases, floodplain development results in the complete or partial loss of the riparian buffer zone. This buffer zone slows runoff and acts as a filter for sediment and pollutants from adjacent development. Loss of this buffer zone is an indication of the loss of riparian wetlands and tree cover necessary for maintaining cool-water temperatures that support aquatic species in the stream.

In addition to development of the floodplain for residential, commercial, and industrial uses, floodplains become storage areas for many types of building materials, timber products (sawdust, logs, and slash), storage structures, propane tanks, recreational vehicles and manufactured homes. The floodplain also becomes a convenient location for the storage of waste materials (both liquids and solids) generated by these land-use conversions. These stored materials and wastes, many of which float or are washed into the stream channel during flood events, become damaging battering rams in the current, contribute to debris dams at bridges and culverts, reduce the hydraulic efficiency of the stream channel, and after flood waters recede are randomly distributed throughout the floodplain. Figure F-8 shows the collection of debris accumulated at a railroad bridge. These floatable wastes can be hazardous to residents and disaster recovery personnel. Debris dams at bridges and other stream crossings artificially raise the flood levels and increase the flood damages to structures adjacent to the bridge. When the debris dam fails, a surge of floodwater carrying timbers, storage tanks, vehicles, houses, rock and silt is unleashed downstream causing more extensive damages.

Figure F-8. Collection of debris at a railroad bridge.

The Task Force recommends that State legislation be enacted that will empower local floodplain management officials to prohibit placement or storage of floatable material within floodways that does not include suitable anchoring. The regulations detailing the legal definition and storage of floatable debris within the 100-year frequency floodplain should be prepared by WVOES in cooperation with WVDEP and WVDNR. Administration and enforcement of these regulations would be through county and municipal floodplain managers using the enforcement powers contained in the floodplain management ordinances. State technical assistance and program oversight for these local enforcement actions would be through WVOES. Additional funding support for local watershed “clean up” activities would assist in addressing stream corridor debris accumulation.

Perhaps the most damaging result of floodplain development is mankind’s response to losses of life and property in the floodplain. Fueled by the misery and losses of those affected by flooding, there follows a socially and politically sympathetic effort by Federal and State agencies to reduce flood damage by constructing dams, modifying stream channels, dredging streams and constructing floodwalls and levees. Figure F-9 shows the construction of a floodwall to protect dense concentrations of development.

Figure F-9. Floodwall construction to reduce damages

Although these efforts do provide relief from flood damage, their costs in terms of financial resources, ongoing maintenance, and the long-term environmental costs to the streams frequently outweigh the flood prevention benefits. More importantly, these flood protection efforts further entrench and expand floodplain development, thereby affirming mankind’s use of the floodplain as the “right” thing to do. To interrupt this development – flood – protect cycle in the floodplain, a well-coordinated comprehensive strategy for reducing floodplain development and managing the State’s floodplains needs to be developed.

Unfortunately, West Virginia’s terrain and land-ownership patterns have confined most development and transportation arteries in the State’s floodplains. The State’s economic future depends on the availability of developable land. Decisions to build in the State’s floodplains have been made by individual property owners until the advent of the National Flood Insurance Program (NFIP). Since enactment of the NFIP, these development decisions have been filtered through local interpretation of the floodplain ordinances. Sometimes that interpretation has been conducted in ignorance of the basis for the ordinances that are designed to account for the probability of future flooding.

In an effort to interrupt this damage cycle, the Task Force recommends that more emphasis (in terms of education, training, funding, and Administrative recognition) be placed upon sound floodplain management by the municipal and county governments. In a state where the majority of developable land is located within the floodplains, the state's economic and social viability is inextricably connected to our wise use of the floodplains in the state.

4. Defining Stream Quality. West Virginia's streams would be considered of the highest quality and value by most professional aquatic ecologists. Many West Virginia streams produce and support significant populations of aquatic flora and fauna that are both intrinsically and economically important to the State. Figure F-10 shows a typical high-quality stream in the State. Historically, the floodplains of many of those same high-quality streams have become home for thousands of West Virginians – a situation that is not in the best interests of either party.

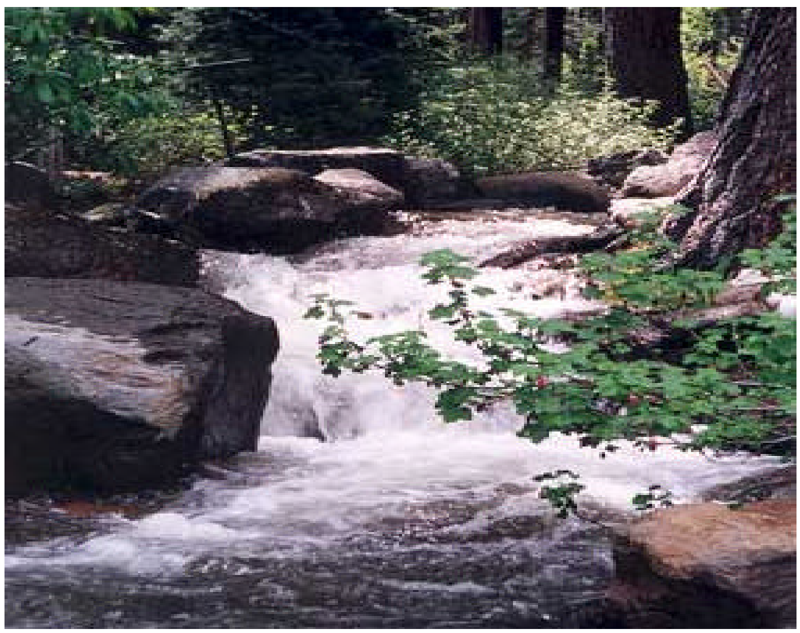

Figure F-10. High quality stream in West Virginia

During development of strategies for reducing flood damages, it became apparent that a wide range of opinions exists at both the Federal and State level concerning processes and criteria used to determine the quality of streams within West Virginia. Each agency within the Task Force uses different criteria for evaluating streams depending on the agency's missions and policy directives. The different views on stream quality and value create uncertainty in the development of various plans when incorporated into the formulation of a comprehensive strategy for flood protection. This uncertainty limits the ability of the Task Force members to propose certain flood protection measures for areas subjected to frequent flooding. This diversity of views on stream quality also limits opportunities to initiate the restoration of stream ecosystems.

To arrive at a common understanding of the procedures for determining stream quality and value, the Task Force recommends that a “Stream Summit” be convened in 2005. This summit would gather the Task Force agencies and other interested stakeholders together and, through discussion and negotiation, determine a process for combining these standards into one classification for waters of the State.

5. Identification and Protection of Stable Streams. Stable streams are defined as streams with a dimension, pattern, and profile that convey the range of flows and effectively transport the sediment produced within the watershed such that the stream neither aggrades (fills in) nor degrades (scours). Figure F-11 is an example of a stable stream condition. Stable streams are characterized by a condition of dynamic equilibrium. Sediment supply is in equilibrium with sediment transport. Slow rates of erosion on the outside of meander bends are matched by similar rates of deposition on point bars.

Figure F-11. Stable stream section showing high quality riparian vegetation

Unstable streams result from a change in any one of the variables that govern stream geomorphology. A disturbance that changes one variable starts a series of changes in other variables resulting in altered channel patterns. Stream geomorphology is therefore the result of these variables adjusting themselves to each other. One of the disturbances that can result in instability is the increase in frequency, magnitude, and duration of bank full flows that can result from development and land conversion in the watershed.

There is a close relationship between the size of a drainage area and the dimensions of the stream channel throughout regions with similar climate and physical geography. (Dunne and Leopold, 1978). A similar relationship exists between channel dimensions and the magnitude of runoff from frequent storm events. Peak discharge from a storm occurring on an interval of from one to three years produces the flow that shapes, sizes, and maintains stream channels (Leopold, Wolman, and Miller, 1964). This peak flow is called the bank-full flow. It follows that a substantial increase in frequency, magnitude, and duration of the peak discharge that generates the bank full flow will increase the stress on stream channels with cause morphological adjustment. Thomas Hammer determined that stream channels in developing areas could enlarge ten to twenty times their cross-sectional area in a process that doesn't return to equilibrium for decades (Hammer, 1973).

Stable streams do not lessen the potential for out-of-bank flooding and damage to development along reaches of stable streams. However, stable streams are better suited to accommodating high flows within the channel without excessive erosion or stream bank failures that increase flood damages. Following the July 2001 floods in southern West Virginia, Federal and State agencies cleared flood debris and sand bars from numerous streams in the affected area. In view of the potential for subsequent flooding that may have resulted from debris and sedimentation in the stream channel, the inherent stability of the stream was not always a concern to those conducting the emergency clean-out operations.

During this same flood event, several streams escaped their channels and reestablished new flow channels. These streams were returned to an excavated, artificial channel that will require years to become stable. Among the many values of stable streams is their use as representative reaches or as archetypes for restoring or reestablishing streams disturbed during construction or through land-use changes in the watershed. Successful stream restoration within a region is more difficult without a representative, stable stream to guide the restoration efforts. Stable streams may or may not be considered high-quality streams according to the Division of Natural Resources. This adds to the confusion associated with classifying streams in West Virginia. Entire lengths or reaches of stable streams are scattered throughout the State. These stable streams need to be identified and protected to avoid future modification.

The Task Force proposes initiating a program for identifying, documenting, and recommending methods for protecting stable stream reaches throughout the State. The initial investigations would concentrate on areas recently impacted by flooding. This would be a collaborative effort of the Department of Environmental Protection, Division of Natural Resources, the Conservation Agency, Natural Resources Conservation Service, the Canaan Valley Institute and Corps of Engineers. This study and the resulting list of streams would be distributed to all Federal and State agencies involved in water resources within the State as well as to all emergency response agencies that direct stream cleanout and debris removal. Best Management Practices (BMPs) for stream cleanout would be prepared by these agencies to guide debris removal in the future.

6. Protection of Wetlands

"Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Water saturation largely determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands may support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favor the growth of specially adapted plants and promote the development of characteristic wetlands soils." — USEPA

Wetlands are important because of their habitat value, ability to store stormwater, ability to allow for surface water infiltration to recharge groundwater aquifers and for their ability to take up and attenuate pollutants. Wetlands function as natural sponges that trap and slowly release surface water, rain, snowmelt, groundwater, and flood waters. Trees, root mats, and other wetland vegetation also slow floodwaters and distribute them over the floodplain. This combined water storage and braking action attenuates flood heights and reduces erosion. Two types of wetland are predominant in West Virginia:

(1) Palustrine (those wetlands associated with streams and rivers), and
(2) Lacustrine (those wetlands associated with lakes and ponds).

Wetlands within and downstream of urban areas are particularly valuable, counteracting the increased rate and volume of surface water runoff from impervious surfaces. Preserving and restoring wetlands, along with other water retaining features, can provide some limited reduction in flood levels.

Wetlands are protected through a series of environmental laws and regulations that date back to 1969. The National Environmental Policy Act of 1969 and the Clean Water Act of 1972 were both instrumental in providing Federal protection for wetlands. Under the Clean Water Act, the U. S. Army Corps of Engineers was given the responsibility for protecting the nation's surfacewater resources including wetlands. The Natural Resources Conservation Service addresses the protection of wetlands on the nation's farmlands. In 1977, President Carter signed executive Order 11990 – Protection of Wetlands in 1977. This order required all Federal agencies to assess the potential impacts of any Federally financed development that might adversely affect wetlands. Generally, these three Federal documents represent the legal protection of wetlands in West Virginia.

Figure F-12 shows a high-mountain wetland. Although West Virginia has fewer wetlands than many states, primarily because of its rugged topography, but there are some well-known wetlands in the State. Wetland complexes in the southern mountains occur on Marsh Fork, Raleigh County; Meadow River, Greenbrier County; Meadow Creek, Fayette County; and Muddlety Creek, Nicholas County. Well-known wetlands of the high mountains include Cranberry Glades, Canaan Valley, Dolly Sods, Pine Swamp, and Cranesville Swamp. Some of the better-known wetlands in western West Virginia are located at McClintic, Green Bottom, Blennerhassett, Boaz, Williamstown, and Winfield. Two popular wetlands in the Eastern Panhandle are Altona-Piedmont Marsh and Town Marsh. Numerous other small wetlands occur throughout the State. Figure F-13 shows a lacustrine wetland.

Figure F-12. High-mountain wetland environment

Figure F-13. Wetland in a lake environment

Wetlands are known by a variety of names such as bogs, marshes, swamps, riparian (streamside), seeps, and wet meadows. Numerous wetlands occur where man-made embankments for roads and railroads impound water. Wetlands are found around the margins of lakes and farm ponds. Most wetlands are dominated by grasses, forbs, shrubs, or trees. The predominant type of wetland in the regional area is associated with streams and rivers and known as palustrine or riparian wetlands.

There are some Federal programs that can be used to restore wetlands on floodplain and/or riparian areas. Among these programs is the Corps of Engineers' Section 206 Aquatic Ecosystem Restoration program. This program provides Federal matching funds to restore aquatic ecosystems, including lakes, ponds, streams and rivers, and wetlands. Areas that, prior to development, were formerly wetlands can be restored provided that environmental benefits can be generated from the restoration. Any State agency, county or local government, or non-profit entity can serve as the non-Federal sponsor for wetland ecosystem restoration. See Chapter 4 of the main report for references to the Section 206 program.

Given the number of Federal and State programs associated with the protection, preservation, and restoration of wetlands in West Virginia, the Task Force recommends that a "Wetlands Summit" be convened in 2005. This summit would be dedicated to the following purposes:

(1) Identifying all Federal, State, and non-profit agencies and groups whose expressed mission, purpose, and/or authorities include the identification, protection, and/or restoration of wetlands,
(2) Assessing the relative health of the State's wetlands, including existing and projected threats to existing wetlands,
(3) Identifying those areas in the State (floodplains and abandoned mine lands) where wetlands restoration could be initiated; and
(4) Identifying potential sources of funding for wetland restoration, purchase of conservation easements or fee acquisition. Several existing members of the Task Force would be present at the summit, including WVDNR, WVDEP, WVCA, USACE, NRCS, CVI, WV Nature Conservancy, and USFWS.